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ABSTRACT

The integration of the National Aeronautics and Space Administration's (NASA's) real-world data and educational environments makes the curricular planning and implementation less focused upon purely theoretical matter and further focused upon the actual day-to-day understanding of difficult conceptual underpinnings of subject matter. This is of primary importance to teacher candidates, who must have such educational endeavors modeled to them as they move through the teacher education curriculum of study and before they are expected to develop curricular scope and sequences on their own. Modeling is of primary importance within coursework, especially methods coursework for teacher candidates, as many instructors teach as they have been taught; the innovations available within today's educational arena must be focused upon in order to break free of the educational ineptitudes of years past and to refocus today's learners upon the importance of understanding theoretical matter within an environment of real-world, data-driven information environments. NASA partnership opportunities offer the real-world environment through which to maintain theoretical grounding of knowledge while reaching towards higher order thinking skills that are necessary within today's world. Teacher candidates must have opportunities to integrate the real-world data and information available through NASA into the instructional design process, so as to design and develop appropriate and successful lessons for their future learners. This paper discusses cross-curricular ventures; provides links to NASA educational World Wide Web sites; outlines interactive learning opportunities; and addresses the issue of meeting national standards. (AEF)

Educational Endeavors for PreK-12 Instructional Design: NASA Partnership Opportunities

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Abstract: National Aeronautics and Space Administration (NASA) offers educational opportunities throughout the nation and maintains educational endeavors for PreK-12 learners as well as teacher education coursework in real-world environments so as to aid the university methods faculty in the real-world uses of NASA-related subject matter and focus.

Introduction

The integration of the National Aeronautics and Space Administration's (NASA's) real-world data and educational environments makes the curricular planning and implementation less focused upon purely theoretical matter and further focused upon the actual day-to-day understanding of difficult conceptual underpinnings of subject matter. This is of primary importance to teacher candidates, who must have such educational endeavors modeled to them as they move through the teacher education curriculum of study and before they are expected to develop curricular scope and sequences on their own.

Modeling is of primary importance within coursework, especially methods coursework for teacher candidates, as many instructors teach as they have been taught; the innovations available within today's educational arena must be focused upon in order to break free of the educational ineptitudes of years past and to refocus today's learners upon the importance of understanding theoretical matter within an environment of real-world, data-driven information environments. It is no longer a viable option to have theories available and memorized by learners; today's environment stresses the use and integration of information into understandable units that can be manipulated to glean the aspects of necessity and importance. Therefore, NASA partnership opportunities offer the real-world environment through which to maintain theoretical grounding of knowledge while reaching towards higher order thinking skills that are necessary within today's world. Teacher candidates must have opportunities to integrate the real-world data and information available through NASA into the instructional design process, so as to design and develop appropriate and successful lessons for their future learners.

Cross-Curricular Ventures

Within the educational environment of today's PreK-12 schools, there has been a growing emphasis upon cross-curricular activities. The theoretical underpinnings that emphasize such a learning opportunity is the clear understanding that all knowledge should be introduced to the learner as a whole, instead of offering "bits and pieces" of important information that the learner must understand and integrate into the "whole" on his or her own. Further, the cross-curricular learning opportunities emphasize the appropriate and successful development of the learner's conceptual framework of understanding, which is based upon the theory of cognitive flexibility and the learning opportunities available within a cross-curricular venue. Spiro and Jeng state that, "By cognitive flexibility, we mean the ability to spontaneously restructure one's knowledge, in many ways, in adaptive response to radically changing situational demands.... This is a function of both the way knowledge is represented (e.g., along multiple rather single conceptual dimensions) and the processes that operate on those mental representations (e.g., processes of schema assembly rather than intact schema retrieval)" (1990, page 165). Additionally, cognitive flexibility "is

largely concerned with transfer of knowledge and skills beyond their initial learning situation" (Kearsley, http://tip.psychology.org/spiro.html, paragraph 2).

As such, NASA's engagement within the PreK-12 educational realm supports cognitive flexibility as well as the cross-curricular development of a learner's conceptual framework. The real-world opportunities that NASA offers to the learners is envisioned as supporting mathematics, science, history, English and language arts, geography as well as numerous other subject areas of emphasis, while supporting the hands-on research of the learners. The integration of technology at every conceivable point is also a supported venture, as technology has the ability to offer real-world data sets, streaming audio and video, graphic elements, Web sites presenting useful information and other interesting aspects that were previously unavailable.

NASA Educational World Wide Web Sites

Numerous Web sites are available through NASA's support of educational ventures within the PreK-12 arena. Such support of the young people is an area that NASA and the professionals associated with NASA have taken as their own personal opportunity to support the educational endeavors of the professional educators of the world's young people, as well as enrich the learning environments with the real-world learning opportunities that not only entertain but also meet important learning objectives. Following are merely a few of the numerous Web sites that support NASA's interest in PreK-12 education. As expected, there is a significant bent towards mathematics and science; however, other disciplines are also valuable and are integrated whenever feasible.

- Practical Uses of Math and Science: The On-line Journal of Math and Science Examples for Pre-College Education
  http://pumas.jpl.nasa.gov/
- InfoUse's PlaneMath
  http://www.planemath.com/
- NASA Spacelink
  http://spacelink.nasa.gov/.index.html
  - Spacelink: Mission Mathematics
    http://spacelink.nasa.gov/Instructional.Materials/Curriculum.Support/Mathematics/Mission.Mathematics/.index.html
- The Space Place
  http://spaceplace.jpl.nasa.gov/teachers_page.htm
- NASA Human Space Flight Metric Converter
  http://www.spaceflight.nasa.gov/station/reference/calc/index.html
- NASA-AMATYC-NSF Mathematics Explorations I and II
  http://cctc.commnet.edu/lta/
- NASA KIDS
  http://kids.msfc.nasa.gov/
  - How Much Would You Weigh on Another Planet?
    http://kids.msfc.nasa.gov/Puzzles/Weight.asp
  - How Old Would You Be on Another Planet?
    http://kids.msfc.nasa.gov/Puzzles/Age.asp
- LTP Glenn Learning Technologies Project
  http://www.grc.nasa.gov/WWW/K-12/airplane/index.html
- Space Science Data Operations Office of NASA/Goddard Space Flight Center: Space Science Education
  http://ssdoo.gsfc.nasa.gov/education/education_home.html
- NASA-JSC Distance Learning Outpost
  http://learningoutpost.jsc.nasa.gov/

Engineers and scientists in the field do not only support the availability of curricular experience; the inclusion and support of professional classroom educators is also an important element within each of the Web sites noted. The desire to enrich the learning experiences available within today's learning environment, as well as heightening the level of interest of young people within the fields of mathematics and science, are important elements towards the success of these programs.

Interactive Learning Opportunities

NASA and their affiliates offer numerous interactive elements through which to enliven the learning environment of the PreK-12 classroom environment, as well as higher education endeavors at the community

college and university levels. The availability of such simplistic information as a lesson plan with integrated activities, through the time-delineated interactive activities with professionals working directly with the learners are available. Following is a short explanation of merely a few opportunities available.

World Wide Web Sites

Web sites developed by NASA and partnering affiliates emphasize numerous points of information as well as interactive elements. For example, PUMAS (http://pumas.jpl.nasa.gov/) "is a collection of one-page examples of how math and science topics taught in K-12 classes can be used in interesting settings, including everyday life" (Kahn, paragraph 1). This site emphasizes the design and development of examples that are primarily written by scientists and engineers, so as to make available peer refereed lesson opportunities to the education profession. It is noted by Kahn that "NASA program directors and other leading representatives of the scientific community have been asking working scientists to contribute to science education" and goes on to write that "part of the motivation for these requests is to encourage and train future scientists, the emphasis has been on helping teach basic 'science literacy' to all students" (http://pumas.jpl.nasa.gov/Short_Intro.html, paragraph 4). Some examples offered in the PUMAS Web site are as follows:

- Coastal Threat: A Story in Unit Conversions
- How Now, Pythagoras?
- Just what is a logarithm, anyway?
- Square Roots Using a Carpenter's Square
  (http://pumas.jpl.nasa.gov/examples/titlef10_1_1_1.htm)

For each of the activities available, the appropriate grade level(s), curricular benchmarks, and subject keywords are available, as well as the peer review timeline to ensure appropriate review of the subject matter and educational viability are met.

As well, simulation learning opportunities are available through NASA sites. One example of an innovative design is InfoUse's PlaneMath (http://www.planemath.com/), which is developed by InfoUse in cooperation with NASA. The PlaneMath Web site offers an interactive opportunity to learn mathematics and aeronautics, with an emphasis placed upon real-world style simulation activities. There is an opportunity for the students to work within the simulation atmospheres associated with the following topics:

- Applying Flying
- Pioneer Plane
- PlaneMath Enterprises

Further, the professional educator or parent has the opportunity to register their class at the Web site. Following are the opportunities available to the professional educator or parent:

- Activities for Students
- Help Me Get Started
- Links to Other Sites
- Parent/Teacher Info

Therefore, there is adequate support available through the NASA and NASA-affiliated Web sites to ensure an appropriate and successful learning opportunity.

Real-World Data Sets

Real-world data sets are available through different venues associated with NASA. Such real-world data sets make available opportunities for learners to take theoretical models and formulas that are usually conjecture and may be perceived as having nothing to do with the daily world of a learner's reality, and move towards a cognitively viable conceptual framework of understanding. One Web site that offers real-world data sets is the NASA-AMATYC-NSF Mathematics Explorations I and II (Capital Community College, 2000) Web site. This site is

maintained for educational purposes and states "The first Project emerged from a desire to create exciting mathematics classroom materials based on NASA space activities" (Capital Community College, 2000, http://cctc.commnet.edu/lta/history.htm, paragraph 1). The original idea was to focus the project towards two-year community college courses; however, this information is just as valuable and viable within secondary classroom learning environments.

Streaming Video and Instructional Television Interactive Sessions

There are numerous venues through which to actively interact through interactive sessions, such as streaming video, instructional television, and videoconferencing. For example, Spacelink (http://spacelink.nasa.gov/) offers annual series of television broadcasts and streaming video broadcasts free to all educational parties. The series integrates mathematics, science and technology through educational distance learning opportunities, with grade-specific subject matter. Distance Learning Outpost, through videoconferencing, allows students to interact with NASA personal through integrated Expeditions and Challenges. Following are a few of the opportunities available, by grade range:

- NASA CONNECT
  Grades: 6-8
  Subject Matter: Mathematics, Science, Technology
  http://spacelink.nasa.gov/Instructional.Materials/Curriculum.Support/Mathematics/NASA.CONNECT/.index.html
- NASA-JSC Distance Learning Outpost
  Grades: K-12
  Subject Matter: Mathematics, Science, Engineering, Geography, and Technology
  http://learningoutpost.jsc.nasa.gov/
- NASA Why Files
  Grades: 3-5
  Subject Matter: None Specified
  http://spacelink.nasa.gov/Instructional.Materials/Curriculum.Support/Mathematics/NASA.Why.Files/.index.html
- NASA Optics
  Grades: K-12
  Subject Matter: Science, Math
  http://spacelink.nasa.gov/Instructional.Materials/Curriculum.Support/Mathematics/Optics/.index.html
- Taking the Measure of the Universe
  Grades: 6-12
  Subject Matter: Measurement and Computation in Mathematics
  http://spacelink.nasa.gov/Instructional.Materials/Curriculum.Support/Mathematics/Taking.the.Measure.of.the.Universe/.index.html

The above-mentioned Web sites are merely a few of the numerous opportunities that NASA and NASA collaborations have made possible to the education profession. Along with the broadcast element, there are also additional flyers, lesson guides and Web activities available for each session. Reviews of the available interactive sessions easily meet course objectives. As well, NASA educational endeavors can also be requested specifically for a classroom's activities and objectives.

Meeting National Standards

Each discipline is supported by national organizations that emphasize the importance of standards at the national level. Through the association's development of national standards, there is a clear vision as to the importance of subject matter taught to teacher candidates as well as emphasized within the PreK-12 curriculum at specific levels through out the learner's progress. As an example, the National Council of Teachers of Mathematics (NCTM) has developed *Professional Standards for Teaching Mathematics* (NCTM, 1991) as well as *Principles and Standards for School Mathematics* (NCTM, 2000). Within each of these standards, at both the teacher candidate and PreK-12 learner levels, technology is a supporting factor towards the success of educational endeavors.

The "Technology Principle" is one of six principles that the National Council of Teachers of Mathematics (NCTM) designate as imperative for all teacher candidates to master (NCTM, 2000). The "Technology Principle" states that "Technology is essential in teaching and learning mathematics; it influences the mathematics that is taught and enhances students' learning" (NCTM, http://www.nctm.org/standards/principles.htm, paragraph 28). However, it is ultimately the mathematics teachers, not the technological tools that have the ability to support the educational goals of each endeavor integrated into the curricular scope and sequence, that is the key to the success of the mathematical learning environment (Garofalo, Drier, Harper, Timmerman & Shockey, 1000; Kaput, 1992; NCTM 1991, 2000). The National Aeronautics and Space Administration (NASA) offers technological opportunities towards the support of educational endeavors and the ability to meld numerous subjects into innovative, real-world, interesting lesson opportunities for PreK-12 learners. Further, the support of NASA offers the teacher candidates opportunities towards successfully meeting NCTM's "Technology Principle" (NCTM, 2000).

Conclusion

The integration of the National Aeronautics and Space Administration's (NASA's) real-world data and educational environments makes the curricular planning and implementation less focused upon purely theoretical matter and further focused upon the real-world understanding of difficult conceptual subject matter underpinnings. Emphasis must be placed upon links between theory and practice within all specialization areas; further, the desire to develop cross-curricular endeavors is also extremely important. NASA and their affiliates should be commended for their efforts, as well as further integration of the available resources should be implemented within teacher education coursework, PreK-12 curriculum, and higher education curriculum.

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